THE AMERICAN BUREAU OF WELDING

THE ADVISORY BOARD ON WELDING RESEARCH AND STANDARDIZATION OF THE AMERICAN WELDING SOCIETY AND OF THE DIVISION OF ENGINEERING OF THE NATIONAL RESEARCH COUNCIL

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THE NATIONAL RESEARCH COUNCIL AND ITS DIVISION OF ENGINEERING

NATIONAL RESEARCH COUNCIL is a coöperative organization of scientific men of America. Its members include, however, not only scientific and technical men, but also business men interested in engineering and industry. Established under the auspices of the National Academy of Sciences, it enjoys coöperation of most of the major scientific and technical societies. Its membership is largely composed of representatives of forty of these societies. The Council was organized in 1916 to coördinate the research facilities of the country for work on war problems. In 1918, by executive order of the President of the United States, it was reorganized as a permanent body for the promotion of scientific research and of the application and dissemination of scientific knowledge for the benefit of the national strength and well-being.

Financial support for the administrative work of the Council is assured by a gift of $5,000,000, made by the Carnegie Corporation in December, 1919. For the support of specific scientific projects the Council relies on special gifts.

National Research Council, while clearly recognizing the unique value of individual work, hopes especially to bring together scattered work and workers, and to assist in coördinating scientific attack in America on large problems, especially those which depend for successful solution on the coöperation of several or many workers and laboratories either within the realm of a single science or in different realms in which various parts of a single problem may lie.

The Division of Engineering, one of the thirteen Divisions of the Council, aims to carry out the general purpose of the National Research Council in the field of engineering by stimulating research and coördinating the work of existing agencies. It seeks to minimize duplication, concentrate effort and stimulate progress, but not in any case to dictate the procedure in its coöperative program or discourage individual initiative.

The Division is made up largely of representatives appointed by engineering societies and members-at-large appointed because of their special fitness. The membership includes fifteen past presidents of engineering societies, high officials of governmental departments and leaders in industry.

Work in each broad field is carried out through a general advisory committee, made up of experts representative of the interested organizations, scientific, engineering and industrial. This advisory com-

mittee, with the assistance of the administrative officers of the Division, selects specific problems for research or other consideration, plans modes of attack, finds men and means for carrying out the plans, coördinates the work of individuals, universities, industries and other agencies, and in general stimulates research on the problems selected. Work on each problem is conducted under the supervision of a special research committee led by a chairman who is a recognized expert. Modes of handling problems differ according to their nature, the facilities available, the geographic distribution of the members and the support tendered by the industries. Results are published in the journal of the engineering society most vitally interested. Support for specific researches must in general come from interested industries. Contributions in some cases are in the form of part-time services of staff engineers, laboratory facilities or material needed for the investigations.

THE AMERICAN WELDING SOCIETY AND THE WELDING OPPORTUNITY

WELDING is now recognized as one of the greatest aids in the construction and repair of metal structures and parts. Its field of application is almost universal in extent. The matter of fastening two pieces of metal together is one of the fundamental problems of mechanical engineering, since all machines and metal structures are made up merely of so many pieces of metal fastened together. As a general proposition the riveted or bolted joint has a tensile strength considerably less than the original piece, whereas the welded joint may be made as strong as the original section. Moreover, a welded joint is oil- and water-tight up to its breaking point, while riveted and caulked joints leak badly at as low as 25 per cent. of their ultimate strength. Considerable economy will also result in time, labor and material in correctly designed welded structures. In the past the wearing of a fraction of a cubic inch of metal from one of the wearing surfaces of a steel part made it necessary to scrap the part with a consequent loss of the labor investment. It was only with the introduction of the autogeneous welding processes that it became possible to stop this economic waste. The repair of broken members of a machine has been another important engineering achievement made possible by the electric, gas and thermit processes.

The American Welding Society is organized to provide united and coöperative action in extending the knowledge of the art of welding and its field of industrial application. The field for further application of welding is enormous, and progress in it is being delayed only by incomplete knowledge and by the confusing and opposing claims of competing interests. The opportunity for increased use of welding divides itself into two fields. The first covers all ordinary work where the weld does not carry the main burden of the structure. This field awaits only the desires of the manufacturers for its development. Already it has been introduced into a great variety of industries, but it is obvious to the most casual observer that its use might be enormously extended with economy. The second field includes the joints that become the strength members of a structure, and must therefore be subject to calculation. It is a noteworthy fact that welding is already used successfully for important work in this field, the cases being those in which the work cannot well be done otherwise. But to secure its general introduction in this class of work much investigation is necessary. Through the American Bureau of Welding, which is an advisory committee of the American Welding Society and con-

cerns itself with Research and Standardization, these investigations will be made in a manner to eliminate duplication and waste and secure results at a minimum cost to the industry.

The American Welding Society acts as a clearing house for information. Through papers and monthly meetings of local Sections of the Society an opportunity is created for the individual manufacturer, engineer, plant superintendent, foreman, operator, etc., to contribute his own knowledge in welding and at the same time receive the benefit of the combined knowledge and experience of all other members of the Society.

Special publications, in addition to the regular monthly proceedings and news circular, are issued from time to time giving results of researches, standardization work and other information of value to the members.

AMERICAN BUREAU OF WELDING

Needs for Research and Standardization

ALTHOUGH the electric, the gas and the thermit processes of welding have been known and used in repair work in the railroad shops and other places for a number of years, welding was up to a few years ago essentially an art, dependent for its success chiefly upon the skill of the operator. As is always true of the technique of a new art, there is no definite agreement as to the best methods of procedure. Moreover, the recommendations of a number of experts are sometimes actually contradictory even in instances where there is no commercial competition. There is hardly any field of development in our industries today which needs as much real sound fundamental research as welding. The problem is very complex from the metallurgical as well as from the mechanical standpoint and requires the most expert talent available. It is one thing to obtain a result and quite a different thing to know the reason why the result was obtained. Satisfactory results have been obtained in the welding field in the majority of cases, but when failures have occurred, the reason why was not always known. The amount of work to be done in order to place welding on a sound foundation is enormous, and the only way it can be done effectively and within a reasonable time is by the hearty coöperation of all interested bodies.

To bring about this coördination of effort there was organized by the American Welding Society and the Division of Engineering of the National Research Council an Advisory Committee on welding research and standardization known as the American Bureau of Welding.

The Bureau consists of twelve representatives appointed by the American Welding Society, two each from each local Section of that society and one each from some twenty other interested scientific, engineering and classification societies and government bureaus. In addition certain members-at-large are appointed because of special fitness.

Corresponding to other general advisory committees of the Division of Engineering in each broad field, the functions of the Bureau are:

(a) To act as the clearing house, steering committee and coördinating agency for research work in the welding field.

(b) To select the most promising and feasible researches and to organize the corresponding research committees.

(c) To consider ways and means for the conduct of these researches.

(d) To deal with all questions of publicity.

(e) To serve as the connecting link between the Division of Engineering and the American Welding Society; to report regularly to the Society and to develop and maintain a really live interest on the part of the Society.

(f) To serve as the connecting link between the Division of Engineering and the Welding Industry.

(g) To aid in stimulating research in and by the welding industry, whether this be by individual corporations or coöperatively by groups of corporations.

Eleven research committees have been created, plans of activities have been outlined and actual work started. In most cases the committees have given a leading place in their program to the preparation of critical summaries of existing knowledge on the most important phases of the work in their field. These summaries will serve the twofold purpose of giving the industry a concise statement of the best existing information and enabling the committee to draw up a careful program of needed research.

Apart from the specific research results, the American Bureau of Welding is beginning to fill a long felt need for an unbiased authority on the many questions arising in connection with this new art. Of these questions some refer to regulatory and safety legislation, some to the training of welders and some to the technique of welding. Answers must be based upon the fundamental scientific facts. Determination of these facts and the reduction of the art to a sound practical and scientific basis is a chief function of the Bureau. Before general confidence in welding can be established, particularly in fields where strength is necessary, its dependability must be satisfactorily demonstrated. The problems of proper welding procedure and training of operators to obtain uniformly sound welds must be solved before such extension in the use of welding can take place. Ordinary evolution of the art would take many years with a resulting loss of millions of dollars to the nation and world.

ELECTRIC ARC WELDING

H. M. HOBART, *Chairman*

ALTHOUGH excellent arc welding is being done on a large scale, there is room for a wide margin of improvement over the present average quality. Considerable research work is necessary, however, to bring about this improvement and to extend the use of electric arc welding to places where it is particularly appropriate. Some of the problems needing investigation are proper amount and kind of current, proper size and composition of electrodes for different thicknesses of plates and for different grades of steel and cast iron, physics of the transference of the metal across the arc, proper method of preparing welding edges and setting up work preparatory to welding, style of joint, number of layers, etc.

The extension of the use of arc welding will without doubt be considerably increased with the solution of the fundamental problem of properly welding a long seam. The successful welding of a long seam is entirely different from making a weld of short length. Due to the continuous contraction of the cooling metal as the weld progresses and the rigidity of the finished portion, stresses of an unknown magnitude are introduced in the welds. In order to successfully design welded structures and to establish confidence in welding it is necessary to know how these stresses can be minimized and also to have some approximate quantitative knowledge of their magnitude in pounds per square inch. A number of methods have been proposed but the scientific data existing on this important problem is seriously inadequate.

The activities of the committee have been chiefly directed into two channels, namely, that of stimulating papers and preparing critical summaries embodying detailed information of the best existing knowledge of various subjects relating to arc welding. Considerable progress has been made in the summary of cast iron welding and a tentative program of research to secure further data has been outlined and the work commenced. Material has also been secured for the summary on the welding of thin metals. This data comprises speeds and current with the use of bare electrodes with automatic and manual feed, with the carbon arc, and with covered electrodes. Other subcommittees are at work on the standardization of arc welding apparatus, electric arc welding in ship construction, physics of the arc and locked-up stresses.

GAS WELDING

S. W. MILLER, *Chairman*

ALTHOUGH a great deal of information is available relative to the practical applications of gas welding, yet if the art is to progress as rapidly as it should, it will be necessary to study many of the fundamental problems in a scientific manner. As in all other processes the cut and try methods that have been previously used are wasteful, although they have produced some valuable results. Some of the fundamental problems that will be investigated by the Committee are effect of different styles of joints, angles of bevel, size of tip, adding metal in different ways and orders, expansion, contraction and preheating. Investigations will also be conducted to determine the proper methods of welding long seams and to secure data on the speed of oxy-acetylene welding.

This Committee is closely coöperating in the work of other committees on those problems in which it is vitally interested and with which its work is intimately associated as, for example, the Committees on Welding Wire Specifications, Steel to be Welded and Training of Welding Operators.

Progress has been made in drawing up summaries for welding pipes and cast iron. A vast amount of data and experience is available on welding of pipes, but no attempt has been made to correlate this information and put it in form that is conveniently useful to the industry. A summary on cast iron is being prepared in coöperation with Electric Arc and Thermit Welding Committees.

RESISTANCE WELDING

H. LEMP, *Chairman*

ALTHOUGH this is one of the oldest and most reliable processes of welding, there are a number of fundamental problems that still remain to be solved. Very recently the limits formerly regarded as the maximum thickness at which plates could be satisfactorily welded by the "seam method" have been surpassed. The same progress has been made in the extension of the use of spot welding. New applications are coming up which require fundamental scientific knowledge of the variables that enter into the successful execution of a resistance weld. Some of these variables are time, current, pressure, methods of clamping (particularly where parts to be welded have different specific heats and melting points). Research work is also needed in the development of the machines themselves.

Sub-committees have been appointed to formulate plans for standardization of nomenclature, rating of welding transformers and units of energy for welding, and preparing critical summaries of the art as its exists today. In order to carry out this work the field of resistance welding was divided under five sub-divisions:

(1) Butt Welding.
(2) Seam Welding.
(3) Spot Welding.
(4) Percussive Welding.
(5) Direct resistance method of heating for the purposes of (a) annealing, (b) hardening, (c) brazing, (d) heating of rivets.

Considerable progress has been made on the standardization of the welding transformers which will prove equitable to the manufacturer, user and central station man. This standardization work is being carried out in close conjunction with A. I. E. E. Standards Committee and will be made to fit in with their other standards. A critical summary on butt welding will soon be finished and ready for publication. Progress has also been made on the summaries relating to seam, spot and percussive welding.

THERMIT WELDING

J. H. Deppeler

RESEARCH work on Thermit Welding is being conducted continually by the Metal and Thermit Corporation and will be extended in those directions found necessary by the needs of the industry. The efforts of the Committee will be confined largely to solving technical problems, supplying information needed by other committees, and bringing up any problems needing further research. Investigations recently conducted cover:

(1) The extraneous materials used in the making of a thermit weld and their effect on soundness.

(2) The dimensions of the gap cut from the section to be welded, the dimensions and proportions of the reinforcing collars and the effect of variations of these on the physical qualities, including tensile strength of the weld.

(3) The effect on the tensile strengths, ductility, resistance to shock and fatigue of variations in the chemical analysis of the steel resulting from the thermit reaction.

In the past the principal difficulty encountered in Thermit Welding was blow holes. Various methods for eliminating the entrapped air were tried out, including methods of pouring and various moulding materials. This has resulted in the use of a molding material consisting of a high grade silica sand of suitable mesh, ground together with a minimum of that plastic clay which in tests at the Bureau of Standards showed the highest fusion point. In the series of hundreds of test welds and actual welding operations it has been proven that this moulding material eliminates the defect known as blow-holes and at the same time give a remarkably smooth and clean exterior to the welds.

At present researches are being conducted along lines tending to further improve the present high standard of the physical qualities of thermit steel, such as tensile strength, ductility, and resistance to shock and fatigue. So far, tensile strengths considerably over 100,000 lbs. per square inch have been obtained in unworked and unheat-treated thermit steel, but here certain other properties were lacking. Others testing invariably over 80,000 lbs. with good ductility and other properties have been made, and it is thought that within a few months definite results can be announced.

STANDARD TESTS FOR WELDS

F. M. FARMER, *Chairman*

STANDARDIZATION of the procedure in making a test of any kind is obviously necessary before results obtained by different observers can be compared.

The chief difference between testing a specimen of steel that included a welded joint and testing an ordinary specimen is the non-homogeneity of the welded specimen. The welded specimen has at its center a section composed of material that usually has physical, chemical and metallurgical characteristics distinctly different from the adjoining metal. Furthermore, the section of the added metal is more or less irregular in shape and variable in size. Consequently the procedure prescribed for testing ordinary specimens is not applicable to specimens containing welded joints.

Differences in details of procedure have caused widely divergent results and comparisons are frequently impossible, consequently the usefulness of much of the research work as recorded is restricted and in many cases the statement of results are actually misleading.

The Committee has drawn up specifications for the standard tests of welds, comprising—

(a) Shop Standard: A simple standard test for such purposes as checking the work of a welder, testing a new lot of welding wire, and testing the effect of some change in conditions.

(b) Commercial Standard: For cases where more than one kind of test should be made but where the circumstances do not justify a complete investigation.

(c) Research Standard: When a complete investigation of a weld is to be made for research or other purposes, all tests and examinations are made which will contribute any information in regard to the characteristics of the weld.

These specifications have been published in the Proceedings of the American Welding Society and also in Bulletin form. They will be modified at the end of twelve months if found desirable.

The Committee expects to consider the feasibility of standardizing methods of making test welds by the automatic machine where it is desired to eliminate the variables due to the human element. The problem of devising satisfactory standards for testing welds in finished structures will also be considered by the Committee. Some information is already available on the subject.

WELDING WIRE SPECIFICATIONS

C. A. McCune, *Chairman*

THERE is urgent need for specifications for both gas and electric arc welding wire. Several years ago a notion prevailed that almost any fence wire was good enough for welding. The chemical analysis of the deposited metal for a great variety of electrodes reveals the fact that the most of the elements alloyed with the iron in the electrode are burned out in traversing the arc, leaving a much more uniform deposit from the viewpoint of a chemical analysis than the wide variation of the chemical composition of the different types of electrodes would lead one to expect. There are some experts and metallurgists who will claim that the method of manufacture has a great deal to do in determining a good electrode. Variation in chemical composition promises to be a more important factor in gas welding rods than in electrodes for metal arc welding. While chemical composition undoubtedly has its effect on penetration and workability in electric arc welding, yet wide variations of the strength of an electric arc weld cannot, from our present knowledge, be attributed to chemical composition alone. On the other hand, a number of experts are of the opinion that the chemical composition of a gas welding rod has a decided influence on the strength and ductility of the resulting weld.

During the greater part of the past year this Committee has been actively engaged in collecting data as to the chemical analysis of welding wire used for both gas and electric welding in railroads, shipyards and general industries and service results obtained from the use of such wire. This data has now been compiled and includes non-ferrous metals used in gas welding. It will be issued in the form of a folio, setting forth the Committee's findings as a guide for the selection of various classes of welding material. The folio is not to be developed into specifications until sufficient knowledge is at hand to warrant the preparation of definite specifications.

Specifications have already been completed for Bare Wire to be used in welding mild steel for both the gas and electric welding processes. A special bulletin will be issued in connection with the abovementioned folio on Coated Electrodes, found to be successful for various welding purposes, with particular reference to the welding of high carbon metals, and for the building up of worn surfaces where great resistance to abrasive wear is desired.

TRAINING OF WELDING OPERATORS

W. SPRARAGEN, *Chairman*

THE importance of the training of operators for both gas and electric welding cannot be overestimated. A large number of welding experts regard it as by far the most important problem. Widely different ideas as to the proper procedure to follow in the training of welding operators prevail even among experts. No agreement exists as to what the training should include or the time required for the training. Some say that the rudiments of a technical education is necessary, while others stoutly maintain that the operator should only be trained in the correct manipulation of the electrode or torch. In nearly every case where welding has been condemned or where severe legislation has been enacted to restrict its use the case can be traced directly to poor welds made by unqualified operators.

A questionnaire has been sent out to a number of welding schools, railroads, shipyards and manufacturing plants asking for detailed information relative to the methods used by them in the training of operators. The data will be used in compiling a bulletin. Some of the elements that will be considered in this bulletin will be welding opportunities; prerequisites for welding operators; general descriptions of methods of training, duration of course, equipment, protection of operators and nomenclature; elementary information on gas and electric welding; set of simple lessons and short bibliography.

Efforts for the present are being confined to drawing up a set of questions which will enable an instructor to obtain a preliminary indication as to whether the prospective student has the necessary qualifications for becoming a good operator. Classification of typical welding jobs to gradually increase the proficiency of new operators will be undertaken and also the standardization of a system or systems of determining the skill of an operator. The ultimate object is to draw up a standard course for the training of welders which will meet the needs of the entire industry, varying from those of the manufacturer who is interested in one particular production job to those of the shipyard and railroad who are training men for all classes of work.

SPECIFICATIONS FOR STEEL TO BE WELDED

W. J. Beck, *Chairman*

IT is now a recognized fact that the chemical composition and quality of the base metal has a decided bearing on the properties of the resulting weld. The A. S. T. M. has a number of specifications covering steel plates in various uses such as locomotive boilers, fire boxes, cars, ships, bridges and buildings. These specifications are alike in construction except for very minor details, and although they do not refer to welding, nearly all of the plates furnished to these specifications are being commercially welded. Much thought has been given lately to the necessity for having specifications of steel to be used for welding purposes. In the preparation of such specifications it is desired to adhere as closely as possible to similar existing specifications of the A. S. T. M., which are practically universally recognized.

Different chemical compositions, notably carbon content, will undoubtedly require different welding procedure. For instance, several authorities maintain that plates having over 0.35 carbon should not be welded where strength of the welding is an important factor. Uniformity of plates is also a subject which merits attention. In the rolling process from the ingot slabs or bars, variations in the physical properties of the plates will be found depending upon the method and type of mill used for rolling and the finishing temperature of the plate in rolling. These factors are again affected by the chemical analysis as above stated. Other important variables are phosphorous, sulphur, manganese and silicon.

At the next meeting of this Committee a definite plan of tests will be formulated to determine the effect of these important factors.

WELDING CONFERENCE COMMITTEE

A. S. Kinsey, *Chairman*

THE committee was organized at the request of the Council of the A. S. M. E. to confer with their Boiler Code Committee in drawing up regulations regarding the use of welding in the construction of pressure vessels. The proposed regulation of the Boiler Code Committee places some severe restrictions on the use of welding for unfired pressure vessels. Through the joint efforts of the Boiler Code Committee and the American Bureau of Welding sub-committees, specifications will be drawn up in regard to the use of welding in the manufacture of pressure vessels which will have the proper requisites for safety without placing unjust restriction on the uses of welding in such constructions.

Program (a). The Committee through the aid of questionnaires has obtained a large amount of detailed information on all of the elements which have entered into the successful welding of pressure vessels in the past. This information was instrumental in convincing the Welding Committees of the A. S. M. E. of the undisputed possibilities of welding in connection with the construction of pressure vessels.

(b) Through a series of test samples, which are being welded both by gas and electric processes at a number of places, the Committee hopes to demonstrate the feasibility of using welding under proper procedure in the construction of pressure vessels with entire safety beyond the restriction now placed on such use by the Boiler Code Committee. These investigations will be extended to destructive tests of full size vessels.

(c) This Committee is also assisting the Boiler Code Committee in drawing up specifications for the construction of pressure vessels insofar as it relates to welding. Considerable progress has already been made.

WELDING OF STORAGE TANKS

J. C. Lincoln, *Chairman*

THIS Committee was organized to meet the requests for information from the Standard Oil Company as to the proper procedure for welding storage tanks for holding light oils. Considerable difficulty has been experienced in the riveted tank because such structures in practice do not prove to be "oil tight" for the lighter oils.

The result of this application of Welding promises not only a cheaper but also a better storage tank and will open up a new and large field to which welding is particularly adapted. Several small tanks have already been built successfully in this way, although the designs were not specially adapted to welding.

Specifications for the electric welding of a tank forty to fifty feet in diameter and twenty-five feet high have been completed. Subcommittees for doing this work by oxy-acetylene and by resistance welding have also been appointed. It is expected that another meeting of the Committee will enable it to complete these specifications. The Standard Oil Company has agreed to construct one of these tanks by welding.

WELDED RAIL JOINTS

G. K. BURGESS, *Chairman*
E. M. T. RYDER, *Vice-Chairman*

THE American Electric Railway Association through its Committee on Way matters has initiated the formation of a Committee on Welded Rail Joints for the purpose of having an authoritative investigation made of the various types of welded rail joints now in commercial use. The American Bureau of Welding as the co-ordinating agency in the general field of welding research and standardization has undertaken to organize this committee.

Welding is being very widely used in making street railway joints and more or less trouble has been experienced in all types of welded joints from breakage. Little or no scientific data exists as to the correct procedure to be followed in making welds by the various processes. Several of the larger companies are spending many thousands of dollars per year on such joints.

A preliminary organization meeting was held on June 9th at the office of Director C. A. Adams and a plan for the organization and conduct of the work was outlined.

The present plans are to organize a relatively large committee, including representatives of users, consumers and also the best technical experts in the field. A number of replies accepting membership have already been received from the larger railway companies. As soon as the organization of the committee is completed a meeting will be called to consider the following points:

(a) Preparation of a bibliography and critical summary of our present knowledge, including the gathering together of all available experience in this field.

(b) Consideration of the results of (a) and the laying out of specific experiments to be performed.

(c) The assigning of each of these experiments of researches to an appropriate laboratory or in the case of field experiments to one or more appropriate operating companies. These assignments would, of course, cover the men under whom these specific experiments will be conducted.

By-Laws
AMERICAN BUREAU OF WELDING

ARTICLE I
Name

The name of this organization shall be the AMERICAN BUREAU OF WELDING.

ARTICLE II
Functions of the Bureau

(1) To act as an advisory body to the American Welding Society and to the Engineering Division of the National Research Council on matters pertaining to welding research.

(2) To act as a coördinating body in welding research and standardization.

(3) To advance the science and art of welding by stimulation of welding research and standardization.

(4) To do all other things incidental or conducive to the above-named objects.

ARTICLE III
Membership

The membership shall consist of—

(a) Twelve representatives appointed by the American Welding Society (selected by the Board of Directors of that Society) for their special fitness and interest in welding research.

(b) Two representatives from each Section of the American Welding Society, one from each Section to be a representative of the Research Committee of such Section and the other to be appointed by the Section to serve on the Ways and Means Committee of the Bureau.

(c) One representative or, upon vote of the Executive Committee, two representatives from each of the following Scientific Societies and Governmental Dements and other interested organizations accepting the invitation to become members.

American Bureau of Shipping.
American Chemical Society.
American Electrochemical Society.
American Engineering Standards Committee.
American Institute of Electrical Engineers.
American Institute of Mining Engineers.
American Physical Society.
American Railway Association.
American Society of Civil Engineers.
American Society of Mechanical Engineers.
American Society of Refrigerating Engineers.
American Society for Testing Materials.
Bureau Veritas.
Engineering Foundation.
Lloyd's Register of Shipping.
National Fire Protection Association.
National Research Council.
New York Academy of Sciences.
Society of Automotive Engineers, Inc.
Society of Naval Architects and Marine Engineers.
United States Department of Commerce, Bureau of Standards.
United States Navy Department.
United States Shipping Board.
United States War Department.
The Federal Board of Vocational Training.

Additional Scientific Societies and Governmental Departments may be invited to appoint representatives to become members upon the approval of the Executive Committee.

(d) Certain members-at-large chosen because of their ability to advance the work of the Bureau. These appointments are to be made by the Executive Committee and shall not at any one time exceed twelve.

ARTICLE IV

There shall be no annual or other dues. Funds for the work of the Bureau shall be secured by voluntary contributions. The solicitation of such funds shall conform to the regulations of the National Research Council and of the American Welding Society.

ARTICLE V

Officers, Nominations and Elections

Section 1. The Officers of the Bureau shall be as follows: A Director, two Vice-Directors, a Secretary and a Treasurer.

Section 2. At the first meeting of the American Bureau of Welding the officers shall be elected by a majority vote of those present and voting, the nominating therefor being made by a committee of five appointed by the Chair. The officers so chosen shall hold office from the date of their election until the next following annual meeting of the Bureau and until their successors shall be elected and qualified.

Section 3. At each annual meeting an election shall be held to select officers of the Bureau for the ensuing year. The officers so chosen shall hold office until the next following annual meeting and until their successors shall be elected and qualified. Any officer shall be eligible for immediate re-election.

Section 4. An interim vacancy among the officers shall be elected by a majority of the members voting by letter ballot, the nominations therefor being made by any ten members in writing to the Secretary at least twenty days prior to the call for said letter ballot.

ARTICLE VI

Duties of Officers

Section 1. The Director shall have general supervision of the affairs of the Bureau subject to its direction. He shall preside at its meetings and shall be ex-officio a member of all committees.

Section 2. In the absence of the Director, a Vice-Director shall preside at meetings of the Bureau and otherwise perform the duties of the Director.

Section 3. The Secretary and Treasurer shall perform the duties usually appertaining to those officers in similar organizations.

ARTICLE VII

Committees

Section 1. The Director shall appoint an Executive Committee, which shall have such power as the Bureau may delegate to it from time to time. In general it will be the function of the Executive Committee to conduct the ordinary business of the Bureau.

Section 2. The Director shall appoint a Ways and Means Committee to devise ways and means for conducting the work of the Bureau.

Section 3. The Bureau shall create from time to time research committees, the Chairmen of which shall be appointed by the Executive Committee. The Chairmen of the several committees so created shall appoint the individual members thereof, subject to the approval of the Executive Committee, to the approval of the American Welding Society and to the approval of the National Research Council.

ARTICLE VIII

Meetings and Notices

Section 1. There shall be an annual meeting of the Bureau to be held on the same day as that of the annual meeting of the American Welding Society.

Section 2. Meetings of the Bureau shall take place at the call of the Director.

Section 3. Notices of all meetings of the Bureau shall be mailed to the members at least two weeks prior to the time of such meetings, except as otherwise provided in these By-Laws, and shall state the time and place of the meeting and the principal business to come before it.

Section 4. Fifteen members shall constitute a quorum.

ARTICLE IX

Voting by Proxies

Section 1. Voting by proxy shall not be allowed at any meeting of the Bureau or of any of its committees, except by a personal representative not otherwise entitled to vote.

ARTICLE X

Publications

Publications of the Bureau in the form of papers will in general be printed in the Proceedings of the American Welding Society. The Executive Committee shall have the authority to pass on all matters relating to publicity and publications of the Bureau and its committees.

ARTICLE XI

Parliamentary Rules

Section 1. Roberts' Rules of order shall be the governing parliamentary law of the Bureau in all cases not definitely provided by its By-Laws or its own rules.

ARTICLE XII

Amendments

Section 1. These By-Laws may be amended, repealed or added to by a majority vote of the members of the Bureau present at any regular meeting or at any special meeting duly called for that purpose.

Section 2. All proposed amendments, repeals or additions to the By-Laws shall be presented to the Secretary in writing at least thirty days prior to the regular or special meeting at which it is desired the same should be considered, and the Secretary shall send a notice which shall contain a copy of such proposal to the members of the Bureau at least ten days prior to such meeting.

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S. W. Miller, Rochester Welding Works.
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